

Computer-Based Instruments

NI 2590/2591 User Manual

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 794 0100

Worldwide Offices

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011,
Canada (Calgary) 403 274 9391, Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,
China (Shanghai) 021 6555 7838, China (ShenZhen) 0755 3904939, Denmark 45 76 26 00,
Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427,
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FCC/Canada Radio Frequency Interference Compliance*

Determining FCC Class

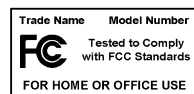
The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.)

Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/DOC Warnings apply in the following sections. (Some products may not be labeled at all for FCC; if so, the reader should then assume these are Class A devices.)

FCC Class A products only display a simple warning statement of one paragraph in length regarding interference and undesired operation. Most of our products are FCC Class A. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

FCC Class B products display either a FCC ID code, starting with the letters **EXN**, or the FCC Class B compliance mark that appears as shown here on the right.

Consult the FCC web site <http://www.fcc.gov> for more information.



FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Mark Declaration of Conformity**, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canadian Department of Communications

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

European Union - Compliance to EEC Directives

Readers in the EU/EEC/EEA must refer to the Manufacturer's Declaration of Conformity (DoC) for information** pertaining to the CE Mark compliance scheme. The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

* Certain exemptions may apply in the USA, see FCC Rules §15.103 **Exempted devices**, and §15.105(c). Also available in sections of CFR 47.

** The CE Mark Declaration of Conformity will contain important supplementary information and instructions for the user or installer.

Conventions

The following conventions are used in this manual:

<>

Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DBIO<3..0>.



This icon denotes a note, which alerts you to important information.



This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.



This icon denotes a warning, which advises you of precautions to take to avoid being electrically shocked.

italic

Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

monospace

Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

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Routing Signals with Your NI 2590/2591

This manual describes the electrical and mechanical characteristics of the NI 2590, a 1×4 , 50Ω , 1.3 GHz multiplexer module, and the NI 2591, a 1×4 , 50Ω , 4.0 GHz multiplexer module, for the PXI bus. It contains information concerning their installation and operation.

About the NI 2590/2591

This section summarizes the features and operation of the NI 2590/2591 switch module; refer to Chapter 2, [NI 2590/2591 Operation](#), for more complete details. In addition, refer to Appendix A, [Specifications](#), for detailed specifications of the switch module.

The NI 2590/2591 are general-purpose, 4-channel, high-bandwidth multiplexing switches.

The NI 2590 uses single-pole double-throw high-bandwidth relays capable of switching signals from DC to 1.3 GHz. The characteristic impedance of the channels is 50Ω . The maximum rated voltage of the switch is 24 VDC, and the maximum rated current is 1 ADC.

The NI 2591 uses a self-contained relay module consisting of three high-bandwidth relays capable of switching signals from DC to 4 GHz. The characteristic impedance of the channels is 50Ω . The maximum rated DC voltage of the module is 30 V. The maximum rated current is 0.33 A.

Triggers

Two triggers are used for handshaking between the NI 2590/2591 switches and other PXI instruments. The *scanner advanced* trigger indicates when the module has closed all the necessary switches for the next scan and the switches have settled, or *debounced*.

The *external trigger input* trigger is generated by another instrument or by software and causes the NI 2590/2591 to advance to the next entry in the scan list. The triggers can be routed to any of the PXI TTL triggers or to the PXI star trigger.

Refer to Chapter 2, *NI 2590/2591 Operation*, for more information on triggers.

RF Switching Precautions

The NI 2590/2591 is a *reflective switch*, meaning that any channels not switched to the common channel are unterminated, and any signal on an unterminated channel will be reflected to its source. For most low-power switching applications this is not a problem. However, operation with an unterminated output can damage some high-power RF sources. Consult your RF source documentation for more information about connecting to unterminated channels.



Caution Always disconnect all signals from the front connectors and power down the PXI chassis before removing the NI 2590/2591 from the chassis. Observe electrostatic discharge handling precautions during and after removal of the module, or when connecting and disconnecting signals on the front panel.



Warning Do *not* exceed the channel-to-ground voltage rating. Any connections that exceed the maximum voltage for the NI 2590/2591 can result in an electrical shock hazard and damage to the switch module and any or all of the modules connected to the PXI backplane. National Instruments is *not* liable for any damages or injuries resulting from exceeding maximum voltage ratings. Refer to Appendix A, *Specifications*, for information.

Contact Protection



Caution The contacts of the relay are rated for a life of 5×10^6 mechanical operations when operated with no signal or a very small signal present. At full rated power—1 A at 24 VDC for the NI 2590 and 0.33 A at 30 VDC for the NI 2591—the life of the switch is downgraded to 100,000 operations. If your setup allows, it is always best to turn off the input signals connected to the switch module during the switching operation to avoid contact arcing within the switch. Switching large inductive loads can also cause contact arcing. In such instances, install a flyback diode or varistor across the inductance to protect the switch.

Connecting Signals

The front of the NI 2590 module has five “push-on” SMB connectors for signal connections. The NI 2591 has five SMA female connectors. The center connection, labeled COM, is connected in a through path to one of the other four connections depending on the software instructions sent to the switch.

NI 2590 Front Connector

The following diagram shows the NI 2590 front connector. Table 1-1 describes the connector signals.

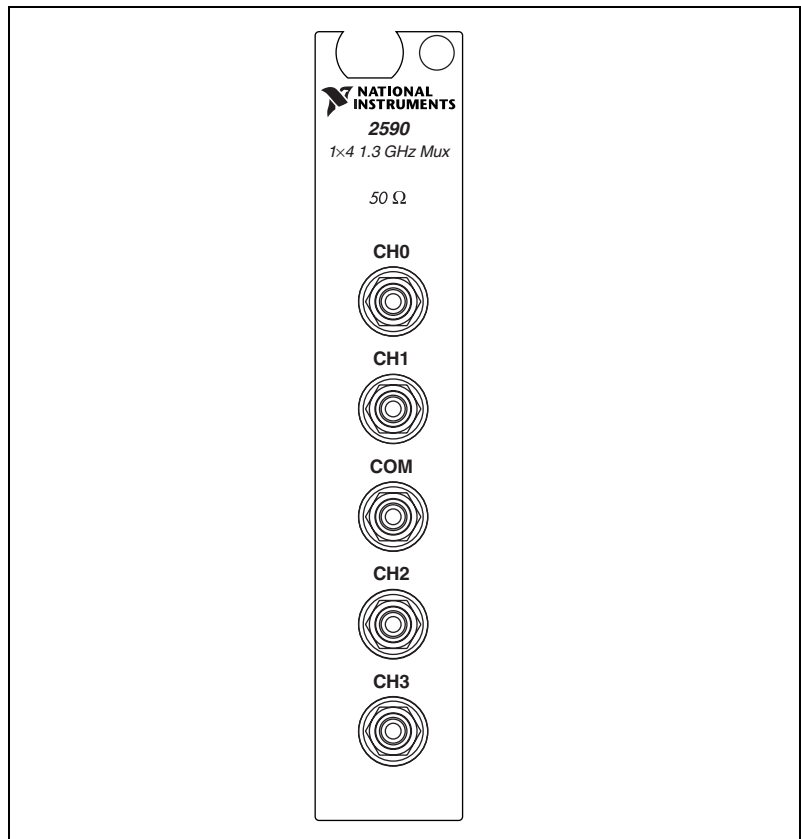


Figure 1-1. NI 2590 Front Connector

NI 2591 Front Connector

The following diagram shows the NI 2591 front connector. Table 1-1 describes the connector signals.

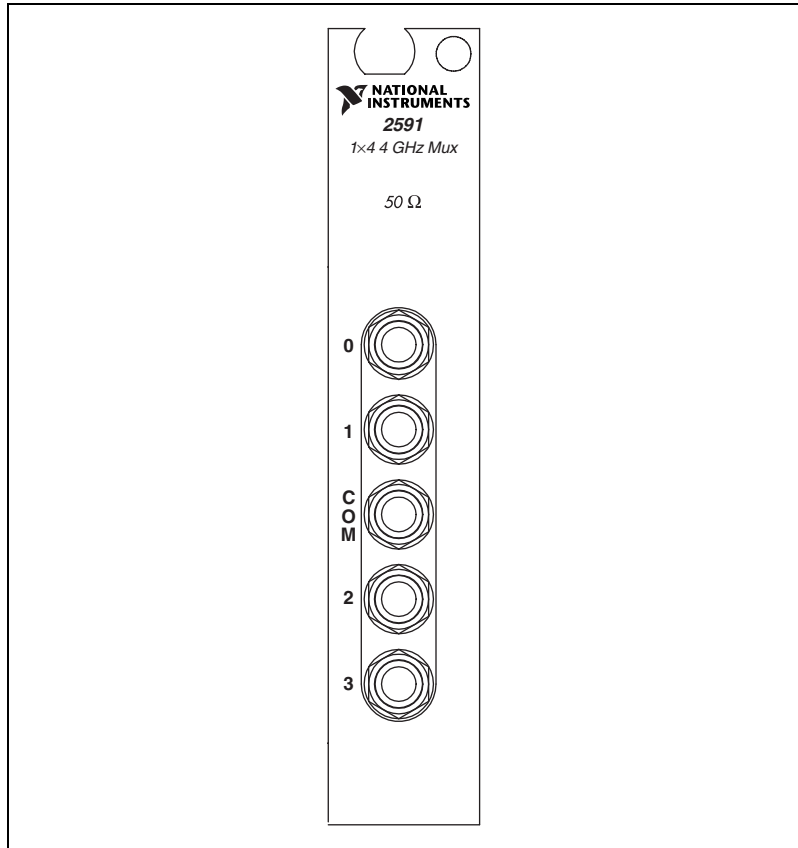


Figure 1-2. NI 2591 Front Connector

Table 1-1. Front Connector Signal Description

| Signal Name | Type | Description |
|-------------|--------------|---|
| CH<0..3> | Input/Output | Channels—Where signals are connected to the switch module |
| COM | Input/Output | Common—The common for the respective channel |

Software Choices

You have several options to choose from when programming your National Instruments switch module. You can use the NI-SWITCH driver software or National Instruments application software.

NI-SWITCH Driver Software

The NI-SWITCH instrument driver is an Interchangeable Virtual Instrument (IVI)-compliant instrument driver that is bundled with the module at no cost.

NI-SWITCH features a set of operations and attributes that exercise all the functionality of the switching hardware, including configuration, opening/closing, and scanning. In addition, NI-SWITCHNI-SWITCH comes with an interactive soft front panel and online documentation.

NI-SWITCH eliminates the need to understand complex register programming and interrupt handling in the Microsoft operating systems, and frees you to focus on creating your test system.

National Instruments Application Software

LabVIEW and LabWindows/CVI are innovative program development software packages for data acquisition and control applications. LabVIEW uses graphical programming, whereas LabWindows/CVI enhances traditional programming languages. Both packages include extensive libraries for data acquisition, instrument control, data analysis, and graphical data presentation. Using LabVIEW or LabWindows/CVI can significantly reduce the development time for your data acquisition and control application.

LabVIEW features interactive graphics, a state-of-the-art user interface, and a powerful graphical programming language. The LabVIEW NI-SWITCH VI Library, a series of virtual instruments (VIs) for using LabVIEW with National Instruments switch hardware, is included with the NI-SWITCH driver.

LabWindows/CVI features interactive graphics, a state-of-the-art user interface, and uses the ANSI standard C programming language. The LabWindows/CVI NI-SWITCH Library, a series of functions for using LabWindows/CVI with National Instruments switch hardware, is included with the NI-SWITCH driver.

Third-Party Software

The NI-SWITCH instrument driver also includes support files for Microsoft Visual C++ and Microsoft Visual Basic. See the *NI-SWITCH Software Readme File* for version support information.

Cabling and Accessory Requirements

National Instruments recommends the use of cables and accessories with 50 Ω characteristic impedance with the NI 2590/2591.

NI 2590/2591 Operation

This chapter contains safety instructions and a functional overview of the NI 2590/2591 switch modules. It also explains the operation of each functional unit making up the switch module.

Safety Instructions



Cautions *Do not operate damaged equipment.* The safety protection features built into this instrument can become impaired if the instrument becomes damaged in any way. If the instrument is damaged, do *not* use it until service-trained personnel can check its safety. If necessary, return the instrument to National Instruments for service and repair to ensure that its safety is not compromised.

Do *not* operate this instrument in a manner that contradicts the information specified in this document. Misuse of this instrument could result in a shock hazard.

Do not substitute parts or modify equipment beyond what is described in Appendix B, [Servicing Your Module](#). Because of the danger of introducing additional hazards, do *not* install unauthorized parts or modify the instrument. Return the instrument to National Instruments for service and repair to ensure that its safety is not compromised.

Connections that exceed any of the maximum signal ratings on the NI 2590/2591 can create a shock or fire hazard or can damage any or all of the devices connected to the NI 2590/2591. National Instruments is *not* liable for any damages or injuries resulting from incorrect signal connections.

Clean instrument and accessories by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with a stiff nonmetallic brush. The unit must be completely dry and free from contaminants before returning to service.

Functional Overview

The following block diagrams illustrate the key functional components of the NI 2590 and NI 2591 switch modules.

The major components of the NI 2590/2591 are as follows:

- General-purpose high-frequency relays
- Switch control circuitry
- Random scanning
- PXIbus interface
- Triggers

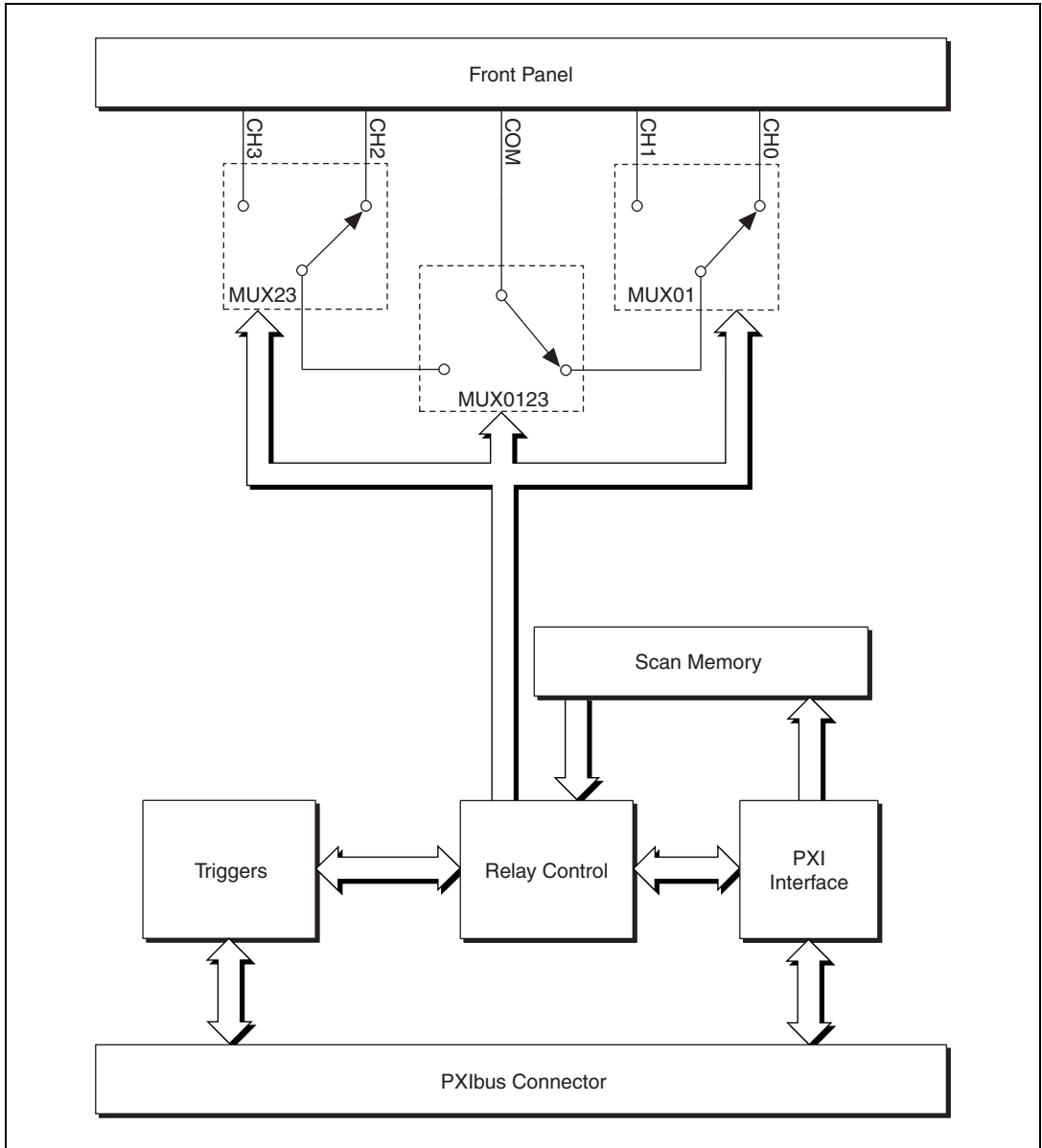


Figure 2-1. NI 2590 Module Block Diagram

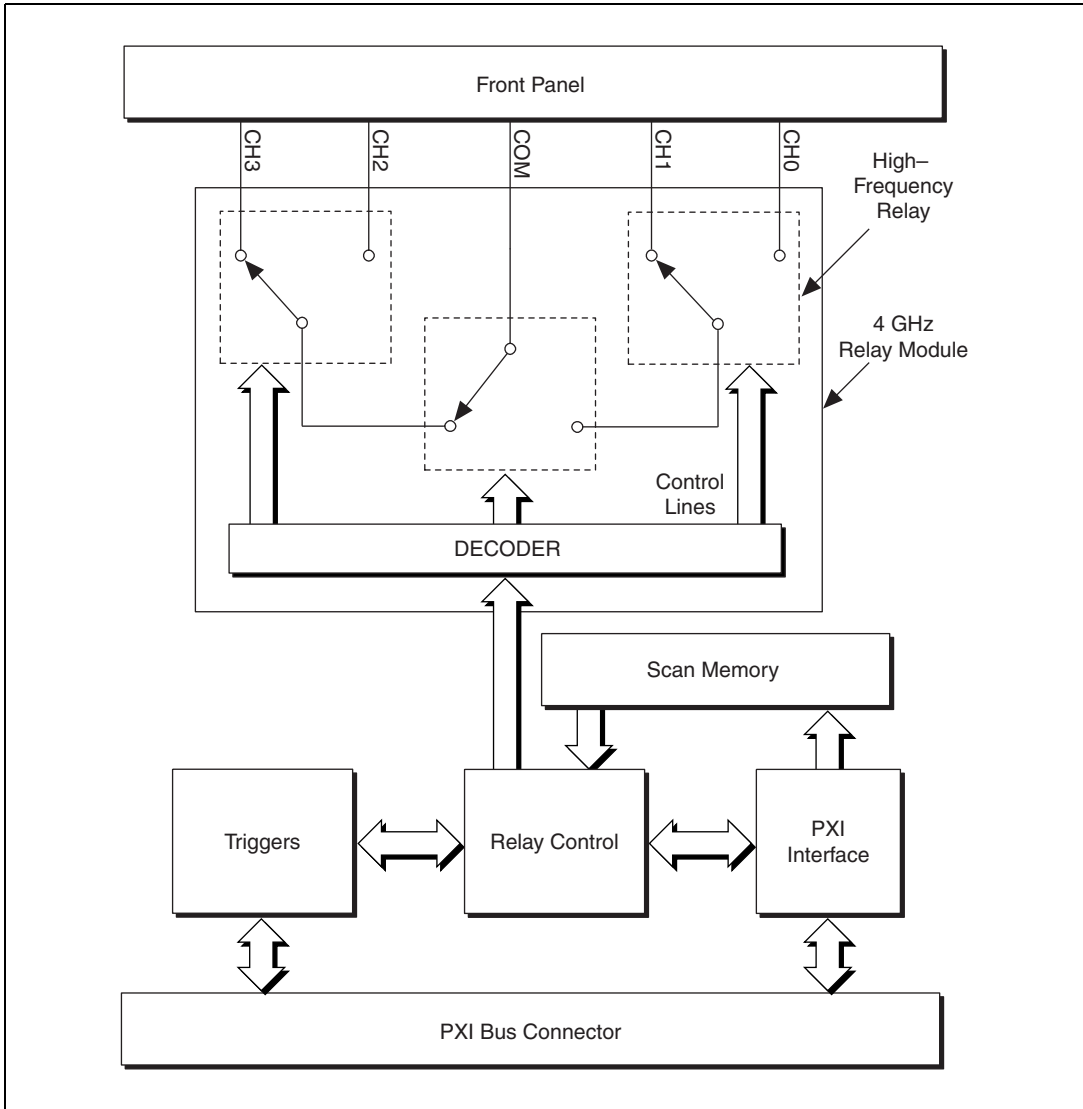


Figure 2-2. NI 2591 Module Block Diagram

Relay Operation

NI 2590 Operation

The NI 2590 has four channels, CH0 through CH3, any one of which can be connected to the single common channel (COM) by closing the appropriate relays.

You can control the relays individually, or you can use higher-level commands to energize the correct relays to connect a channel (such as CH0) to COM. Only one channel can be connected to the common channel at any time, and it is not possible to connect one channel to another channel bypassing the common channel.

The NI 2590 relays are single-side stable. When power is removed from the relay coil, the relay returns to its de-energized state. When all three relays are de-energized, the default connection is from CH0 to COM, as shown in Figure 2-1. To connect CH2 to COM, you energize MUX0123; to connect CH3 to COM, you energize MUX0123 and MUX23. You can specify the channel to connect to COM and let the NI-Switch driver energize the appropriate relays for you. Refer to the *NI-SWITCH Software User Manual* for further information.

NI 2591 Operation

The NI 2591 is very similar to the NI 2590 in some respects, but different in others. The NI 2591 has 4 channels, CH0 through CH3, any one of which can be connected to the single COM by closing the appropriate relays.

The NI 2591 does not allow for control of the individual relays. You must use the high-level commands to connect the channels, such as CH2 to COM. Only one channel can be connected to the common channel at any time, and it is not possible to connect one channel to another channel, bypassing the common channel. The default (power off) connection of the NI 2591 is CH3 to COM. Refer to Figure 2-2 to see how the connections in the NI 2591 are made.

Switch Control Circuitry

The switch control circuitry (SCC) is responsible for opening and closing relays on the NI 2590/2591. You can load commands for the SCC into scan memory using the driver software you received with your kit. Consult the online help or your software documentation for specific information on the appropriate commands. There are two reasons for storing the commands in memory before the SCC can process them:

- Both the operate and release times for the NI 2590/2591 are 15 ms. Using memory storage, the software can send multiple commands to the SCC without having to wait for a relay action to complete.
- The memory is used to store a scan list necessary for hardware random scanning.

Random Scanning

The NI 2590/2591 can perform random scanning. In random scanning, the switch module can open or close relays in any order.

The scan list is downloaded to onboard memory. Commands in the scan list can perform the following actions:

- Open or close relays
- Wait for an external trigger
- Generate a scanner advanced trigger
- Generate a breakpoint interrupt

You can use the driver software to configure the switch module for continuous or one-time scanning. In continuous scanning, the switch module cycles through the scan list until you disable scanning. For one-time scanning, the switch module runs through the scan list only once.

You can also use software commands to clear the scan list or reset it to the beginning at any time.

The onboard control logic for the NI 2590/2591 switch module gives you direct access to open and close the relays, and also the ability to download up to 1,024 random scanning instructions. The software included with the module automatically configures the NI 2590/2591 and downloads the scan list to hardware for you. The scan list itself downloads directly into the memory of the module to deliver the fastest scan possible with no controller

intervention. You can configure the switch module to process the scan list once or to continuously loop through the scan list.

PXI Interface

You can configure and control your NI 2590/2591 switch module through the PXI interface, taking advantage of PXI features. The NI 2590/2591 uses the PXI TTL triggers to synchronize scanning with a measurement device such as the NI 5102 (PXI) 20 MS/s oscilloscope, or the NI 5411 for PXI arbitrary waveform generator.

PXI Triggers

External Trigger Input

The NI 2590/2591 can use an external trigger input to advance between scan setups in a scan list. Using the driver software, you can configure the switch module to route the external trigger from any of the PXI TTL trigger lines or the PXI star trigger. Alternatively, you can use a software command to trigger the switch module.

All external trigger lines are compatible with TTL voltage levels and are edge sensitive. The minimum pulse width from the PXI TTL triggers and PXI star trigger is 70 ns.

Scanner Advanced

The NI 2590/2591 can generate a scanner advanced trigger to indicate when the switch module is set up and ready to take measurements. Using the driver software, you can configure the switch module to route the scanner advanced (SCANADV) trigger to any PXI TTL trigger line or to the PXI star trigger. You can configure the switch module to generate the SCANADV trigger when a relay has settled (or debounced).

Because the NI 2590/2591 has open-collector drivers on the PXI TTL trigger lines, you can have multiple switch modules using the same trigger line in the multiboard SCANADV mode.

Modes

SCANADV has two modes of operation. In its default mode, the SCANADV trigger asserts for 1 μ s after the relay has debounced. You can also configure the switch module for handshaking mode, in which the SCANADV trigger goes high after a relay settles, and the SCANADV trigger goes low after the external trigger input asserts. You can use this handshaking mode for multiboard scanning.



Note The NI 2590/2591 ignores external triggers when it is not in a wait-for-trigger state while scanning.

Initiating Scanning

When you use the NI 2590/2591 to initiate a scan, make sure the measurement device is armed (waiting for trigger) before enabling scanning on the switch module. Enabling scanning causes the first switch(es) in the scan list to close and generates a scanner advanced trigger after the relay switches have settled or debounced.

When you use the measurement device to initiate a scan, make sure scanning is enabled on the NI 2590/2591 before the measurement device starts to take measurements. This ensures that the switch module has the correct signal routed and that the switch module is waiting for an external trigger from the measurement device.

Always configure the triggers in a system before configuring the measurement device or the NI 2590/2591 for scanning. When triggers are configured, a state change or pulse could occur on the trigger line. This is also possible when you reset the switch module.

Multiboard Triggering

You can use multiple NI 2590/2591 switch modules—or multiple other National Instruments switch modules such as the NI 2503—together in conjunction with an instrument such as a National Instruments oscilloscope/digitizer. In multiple switch-module systems, be sure to identify one switch module as the master switch module.

All other switch modules for the system are identified as slave switch modules. The master switch module can route an external trigger from the front connector to a PXI backplane trigger. In addition, the master switch module can route the SCANADV trigger from the PXI backplane to either the front connector or another backplane trigger. This functionality makes

it possible to wire external triggers from/to only one switch module in the system, which simplifies the wiring scheme.



Note The NI 2590/2591 does not support triggers on the front panel connector. If the trigger signal is external to the chassis, you must use a different National Instruments switch module, such as the NI 2503, as the master switch module.

For more information, refer to the *NI-SWITCH Software User Manual*.

Specifications

This appendix lists the specifications for the NI 2590/2591 switch module. These specifications are typical at 25 °C unless otherwise noted.

NI 2590

Input Characteristics

| | |
|---|----------------------------|
| Number of relays..... | 3 |
| Common-mode voltage | |
| Channel to earth | 24 VDC |
| Maximum switching voltage | |
| AC..... | 24 V _{rms} |
| DC..... | 24 VDC |
| Maximum switching capacity per channel | |
| DC..... | 1 A at 24 V |
| AC..... | 1 A _{rms} at 24 V |
| Maximum switching power per channel | 24 W |
| Contact on resistance (initial) | 100 mΩ max |
| Contact material | Gold-clad silver |

RF Performance Characteristics

| | |
|---|----------|
| Characteristic impedance (Z_0)..... | 50 Ω |
| Insertion loss at: | |
| < 100 MHz | < 0.4 dB |
| < 500 MHz | < 0.9 dB |
| < 1.3 GHz..... | < 1.5 dB |

VSWR at:

| | |
|-----------------|--------|
| < 100 MHz..... | < 1.15 |
| < 500 MHz..... | < 1.35 |
| < 1.3 GHz | < 1.5 |

Isolation:

| | |
|-----------------|----------|
| < 500 MHz..... | < -62 dB |
| < 1.3 GHz | < -50 dB |

Risetime< 300 ps

Signal delay< 3 ns

Maximum RF carry power
at 900 MHz10 W



Note Refer to the cautions and warning in the *RF Switching Precautions* and *Contact Protection* sections of Chapter 1, *Routing Signals with Your NI 2590/2591*, for important information about using your NI 2590/2591 with high-power signals.

Dynamic Characteristics

Relay operate time (at 20 °C)

Typical.....15 ms

Relay release time (at 20 °C)

Typical.....15 ms

Expected life

Mechanical (no load)..... 5×10^6 operations

Electrical at maximum
switching capacity 10^5 operations



Caution Exceeding the maximum switching capability will decrease the expected life of the NI 2590/2591.

PXI Bus Interface

Slave

PXI Trigger Bus

| | |
|---------------------|---|
| Trigger lines | 8 |
| Star trigger..... | 1 |

Power Requirement

+5 VDC

Minimum (all relays opened)..... 350 mA

Maximum (all relays closed) 0.6 A

Physical

| | |
|--------------------|---|
| Dimensions..... | 10 by 16 by 4 cm (3.9 by 6.3 by 1.6 in.) |
| Weight..... | 240 g (8.5 oz) |
| I/O connector..... | 5 SMB female |

Environment

| | |
|-----------------------------|------------------------|
| Operating temperature | 0 to 50 °C |
| Storage temperature..... | -20 to 70 °C |
| Relative humidity | 5 to 85% noncondensing |
| Maximum altitude | 2,000 m |

Certifications and Compliances

CE Mark Compliance

See the Declaration of Conformity sheet accompanying product.

NI 2591

Input Characteristics

| | |
|--|--|
| Number of relays | 3 |
| Common-mode voltage | |
| Channel to earth..... | 30 V _{rms} or DC |
| Maximum switching voltage | |
| AC..... | 30 V _{rms} |
| DC..... | 30 VDC |
| Maximum switching capacity per channel | |
| DC..... | 30 VDC at 0.33 ADC |
| AC..... | 30 V _{rms} at 0.33 A _{rms} |
| Maximum switching power per channel..... | 10 W |
| Contact on resistance (initial) | 200 mΩ max |
| Contact material..... | Gold |

RF Performance Characteristics

| | |
|--|----------|
| Characteristic impedance (Z_0) | 50 Ω |
| Insertion loss at: | |
| < 2.5 GHz | < 0.6 dB |
| < 4 GHz | < 0.9 dB |
| VSWR at: | |
| < 2.5 GHz | < 1.3 |
| < 4 GHz | < 1.5 |
| Isolation: | |
| < 2.5 GHz | < -60 dB |
| < 4 GHz | < -55 dB |
| Maximum RF carry power at 900 MHz | 10 W |



Note Refer to the safety information in Chapter 2, *NI 2590/2591 Operation*, for important information about using your NI 2591 with high-power signals.

Dynamic Characteristics

| | |
|--|----------------------------|
| Relay operate time (at 20 °C) | |
| Typical | 15 ms |
| Relay release time (at 20 °C) | |
| Typical | 15 ms |
| Expected life | |
| Mechanical (no load) | 5×10^6 operations |
| Electrical at maximum switching capacity..... | 10^5 operations |



Caution Exceeding the maximum switching capability will decrease the expected life of the NI 2591.

Power Requirement

| | |
|-----------------------------------|--------|
| +5 VDC | |
| Maximum (all relays closed) | 250 mW |

Physical

| | |
|--------------------|---|
| Weight..... | 1.1 kg |
| Dimensions..... | 10 by 16 by 4 cm (3.9 by 6.3 by 1.6 in.) |
| I/O connector..... | 5 SMA female per bank |

Environment

| | |
|-----------------------------|------------------------|
| Operating temperature | 0 to 50 °C |
| Storage temperature..... | -20 to 70 °C |
| Relative humidity | 5 to 85% noncondensing |

Electromagnetic compatibility

(EMC) emissionsRefer to the document supplied with the chassis for compliance to relevant directives.

EMI.....FCC Class A compliant

Maximum altitude.....2,000 m

Certifications and Compliances

CE Mark Compliance

See the Declaration of Conformity sheet accompanying product.

Servicing Your Module

This appendix describes procedures for servicing your NI 2590/2591 module.

Replacing the NI 2590 Relay Module

The NI 2590 is constructed so that the relay module can be replaced when the relays fail. The life of the relay is nominally 10^5 operations when switching the maximum rated load.

You can order an RF 2590 replacement relay module for your NI 2590 from National Instruments. The replacement kit contains the fully assembled module.

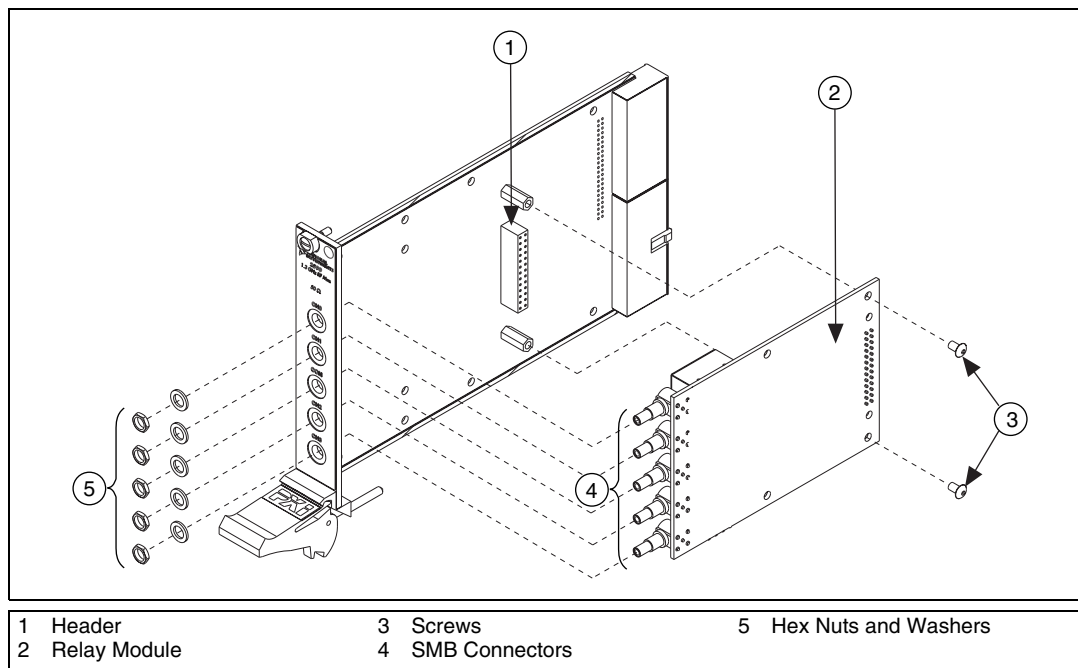


Figure B-1. NI 2590 Parts Locator Diagram

Follow these instructions to replace the failed module as shown in Figure B-1.

1. Ground yourself with a grounding strap or a ground connected to your PXI chassis. Properly grounding yourself prevents damage to your PXI module from electrostatic discharge.
2. Remove the two Phillips-head screws that fasten the NI 2590 relay module board to the module carrier.
3. Remove the hex nuts and washers from the SMB connectors on the front panel.
4. Gently disconnect the rear of the module from the header, then carefully remove the module.
5. Install the replacement module and screws in reverse order, taking care not to damage the connector pins on the module.

Replacing the NI 2591 Relay Module

The NI 2591 is constructed so that the relay module can be replaced when the relays fail. The life of the relay is nominally 10^5 operations when switching the maximum rated load.

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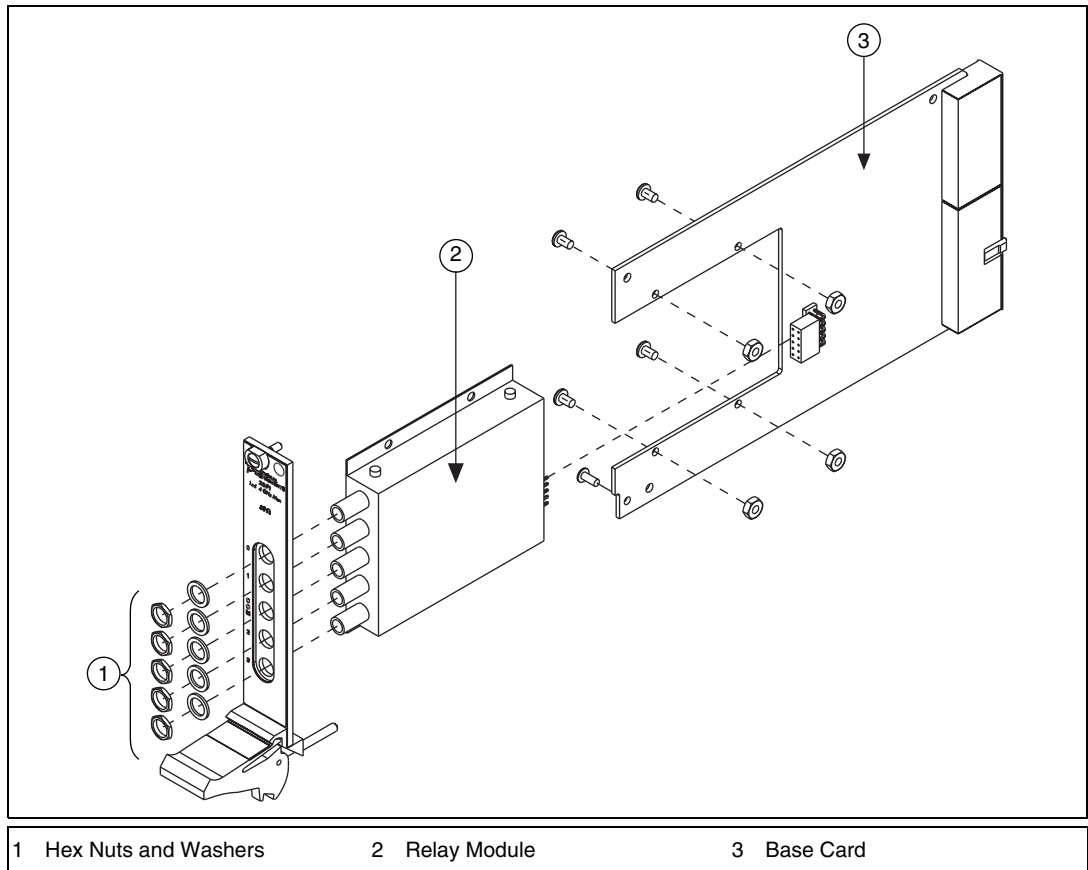


Figure B-2. RF 2591 Replacement Relay Module

Follow these instructions to replace the failed module as shown in Figure B-2.

1. Ground yourself with a grounding strap or a ground connected to your PXI chassis. Properly grounding yourself prevents damage to your PXI module from electrostatic discharge.
2. Remove the four Phillips-head screws and nuts that fasten the NI 2591 relay module to the module carrier.
3. Remove the hex nuts and washers from the SMA connectors on the front panel.
4. Remove the PXI ejector handle screw that secures the front panel.
5. Remove the module from the base card.
6. Install the replacement module and screws in reverse order, taking care not to damage the connector pins on the module.



Common Questions

This appendix addresses common questions you may have while using your NI 2590/2591 switch module.

What should I do if the software detects the module but the switches do not switch?

Verify that the switches do not switch. Close your application program and then launch the soft front panel as described in the Set up and Test document you received with your kit. The soft front panel shows the state of each relay on the module. Try closing and opening the switches.

Also be sure to check the return codes of the NI-Switch operation to ensure that there are no errors (negative value) or warnings (positive value). You can also use the NI-Spy utility to check for error codes.

Finally, verify that your code is correct. For reference, see the examples described in the *NI-SWITCH Software User Manual*. The NI-Switch driver also ships with several examples in source code. Compare your algorithm to those in the examples.

What should I do if scanning does not work?

First, ensure that you have configured the switch module and the instrument to match trigger lines. The output trigger of the instrument should connect to the trigger input of the switch module. In addition, the scanner advanced trigger of the switch module should be connected to the input trigger of the instrument.

If the switch module is used to initiate the scan, make sure the scope or arb is waiting for a trigger before enabling scanning on the switch module. This is the recommended method for hardware scanning.

If the scope or arb is used to initiate the scan, enable scanning on the switch module before configuring the scope or arb to start taking measurements.

Also be sure to check the return codes of the NI-Switch operation to ensure that there are no errors (negative value) or warnings (positive value). You can also use the NI-Spy utility to check for error codes.

Finally, verify that your code is correct. For reference, see the examples described in the *NI-SWITCH Software User Manual*. The NI-Switch driver also ships with several examples in source code. Compare your algorithm to the ones in the examples.

Do I need to program the switch module myself?

The NI 2590/2591 comes with the NI-Switch driver software, which exports the full functionality of the module. NI-Switch handles the complex issues of direct memory access, interrupts, and operating system interfacing.

Technical Support Resources

Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of ni.com

NI Developer Zone

The NI Developer Zone at ni.com/zone is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of ni.com for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of ni.com

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of ni.com. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

| Prefix | Meaning | Value |
|---------|---------|------------|
| p- | pico- | 10^{-12} |
| n- | nano- | 10^{-9} |
| μ - | micro- | 10^{-6} |
| m- | milli- | 10^{-3} |
| M- | mega- | 10^6 |
| G- | giga- | 10^9 |

Numbers and Symbols

| | |
|----------|--------------|
| ° | degrees |
| Ω | ohms |
| % | percent |
| > | greater than |
| < | less than |

A

| | |
|------|---------------------------------------|
| A | amperes |
| AC | alternating current |
| ADC | amperes direct current |
| ANSI | American National Standards Institute |

B

| | |
|------------|--|
| breakpoint | a specified point in program code where the program pauses to perform some action; a breakpoint interrupt can be added to a scan list for debugging or other special needs. |
| bus | the group of conductors that interconnect individual circuitry in a computer. Typically, a bus is the expansion vehicle to which I/O or other devices are connected. Examples of PC buses are the ISA and PCI bus. |

C

| | |
|----------------|--|
| C | Celsius |
| channel | pin or wire lead on the multiplexer to which you apply or from which you read the signal |
| common | a channel that is typically the output of a switch module |
| contact bounce | the intermittent switching that occurs when the movable metal parts of a relay make or break contact |

D

| | |
|-------------------------|---|
| DC | direct current |
| debounced | indicates when the contact bounce has ended. <i>See</i> contact bounce. |
| device | a plug-in module, board, or pad that can contain multiple channels and conversion devices. Some examples of devices are computers, multimeters, multiplexers, oscillators, operator interfaces, and counters. |
| diode | an electronic component that acts primarily as a one-way valve |
| drivers/driver software | software that controls a specific hardware device such as a switch module |

E

| | |
|------------------|---|
| external trigger | a voltage pulse from an external source that triggers an event such as A/D conversion |
|------------------|---|

F

flyback voltage the voltage spike generated the instant current stops flowing through an inductor

H

handshaking the use of two trigger lines between two instruments, such as a switch and a DMM, to synchronize their actions

Hz hertz—the number of scans read or updates written per second

I

in. inches

Interchangeable
Virtual Instrument an advanced architecture for instrument drivers that includes features such as simulation and state caching

I/O input/output—the transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces

ISA Industry Standard Architecture

IVI *See* Interchangeable Virtual Instrument.

N

NI-Switch an IVI-based instrument driver that supports the National Instruments line of switch modules

P

PXI PCI with extensions for instrumentation

R

| | |
|-------------------|---|
| random scanning | scanning the channels in a mux in any order |
| reflective switch | a switch architecture in which the unused channels are NOT terminated in the characteristic impedance of the system. The unused channels are open circuits. |
| relay | a switch that connects or disconnects the signal to a common through the physical movement of a metal arm |
| rms | root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude |

S

| | |
|--------------------------|---|
| s | seconds |
| scan | the data acquisition of signals connected to multiple channels of a multiplexer. Typically, the measurement device uses a trigger to advance the multiplexer to the next channel in the scan. |
| scan list | a list of channels supplied to NI-Switch that indicates the order in which channels will be scanned |
| scanner advanced trigger | the trigger generated by the switch module when scanning. The trigger occurs after the switch module has closed a switch and the switch has settled. |
| SCC | switch control circuitry |
| SMB | sub-miniature snap-on connector |
| soft front panel | a graphical program included with NI-Switch that you can use to interactively control the switch |

T

| | |
|---------|---|
| trigger | any event that causes or starts some form of data capture |
| TTL | Transistor-Transistor Logic |

V

V volts

varistor an electrical resistor whose resistance depends on the applied voltage

VDC volts, direct current

VI virtual instrument—(1) a combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument (2) a LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program

VSWR Voltage Standing Wave Ratio. The impedance match of the device to the overall system.

W

W watts

wire data path between nodes

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